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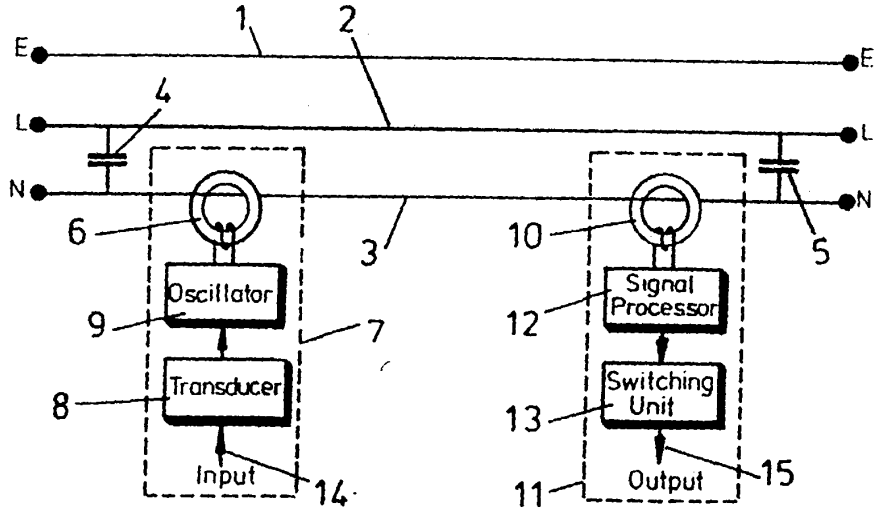

(57) Abstract

A system and method for signalling through a power cable. At least one capacitor is connected between first and second conductors of the power cable to define a closed loop incorporating portions of the first and second conductors. Signals are injected into the closed loop via a first transformer a winding of which is connected in series with the closed loop. Signals are received from the power cable via a second transformer a winding of which is connected in series with the closed loop. Thus, signals applied to the first transformer may be transmitted to the receiver through the power cable.

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SIGNALLING SYSTEM AND METHOD

The present invention relates to a system and method for signalling through a power cable.

There are many circumstances in which it would be convenient to transmit signals through a power cable. For example, in premises that have previously been wired, it may be desired to add further control circuitry without it being necessary to introduce an entirely new wiring circuit. In many circumstances new wiring circuits can only be inserted if one is prepared to damage and subsequently repair and redecorate visible surfaces. This dramatically increases the total costs associated with the introduction of the new circuit.

For example, it may be desired to introduce in to a room a passive infra-red detector positioned so as to be sensitive to the entry of a person into that room and arranged to turn on lights positioned to illuminate that room. Generally this requires positioning the infra-red sensor and the controlled lighting unit at spaced apart locations and introducing cabling to pick up power from an adjacent existing power cable and to link the sensor and the lighting unit. The structure of the premises is often such that it is very difficult to introduce the cabling linking the sensor and the lighting unit.

Various proposals have been made for transmitting control signals via existing power cables. For example in one known system intruder detector devices are plugged into the mains power distribution of a home and, when an intruder is detected, transmit a coded signal through the mains power network to a central alarm unit. That central alarm unit which is also connected to the power system then energises an alarm. Such systems present various problems. Firstly, noise on a power distribution network can corrupt the data represented by the transmitted codes. Secondly, coded signals can be transmitted through the power network between adjacent premises causing a faulty system response in one of the premises as a result of an event occurring in the other premises. Thirdly, the connection of relatively sophisticated electronic components to mains cabling to which inevitably large voltage spikes are applied during the normal operation of power consuming devices can result in component failures. Accordingly the use of such systems in the past has been limited due

to doubts as to system reliability and safety.

It is an object of the present invention to obviate or mitigate the problems outlined above.

According to the present invention, there is provided a method for signalling through a power cable, wherein at least one capacitor is connected between first and second conductors of the power cable to define a closed loop incorporating portions of the first and second conductors, signals are injected into the closed loop via a first transformer a winding of which is connected in series with the closed loop, and signals are received from the power cable via a second transformer a winding of which is connected in series with the closed loop.

The present invention also provides a system for signalling through a power cable, comprising a signal transmitter, a signal receiver, at least one capacitor connected between first and second conductors of the cable to define a closed signal loop, a first transformer having a first winding in series with the signal loop and a second winding connected to the transmitter, and a second transformer having a first winding in series with the signal loop and a second winding connected to the receiver, whereby signals applied to the first transformer by the transmitter may be detected by the receiver connected to the second transformer after transmission through the closed signal loop defined by the first and second conductors and said at least one capacitor.

Generally two capacitors will be connected between the first and second conductors at locations spaced apart along the length of the cable, each transformer being connected to the cable between the capacitors adjacent a respective one of the capacitors. In some power networks however two conductors in a power cable are connected at a power distribution point. This is the case in so called PME earthing systems in which neutral and earth conductor are directly connected. In such circumstances the required closed signal loop can be defined by a single capacitor connected between the neutral and earth conductors.

Each transformer may be of any convenient type, for example a simple toroidal core threaded by one of the power cable conductors and by a wire representing the second winding which is looped a few

times around the core. The toroidal cores may be single piece components, in which case it is necessary to disconnect the relevant conductor of the power cable and thread it physically through the core, but in an alternative arrangement each core may be split into two halves that can be positioned around a conductor of a power cable without in any way disconnecting that power cable.

Thus the present invention enables signals to be readily transmitted onto and received from a power cable. Furthermore, the signals transmitted onto the power cable are isolated within the closed loop defined either between the two capacitors or between a single capacitor and a direct electrical connection between the two conductors. The transformers provide whatever degree of mains voltage isolation is required. Thus the problems of noise, signals leaking between different sections of a power network, and inadequate power voltage isolation are easily overcome.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates a first embodiment of the present invention; and

Figure 2 illustrates a second embodiment of the invention.

With reference to Figure 1, a power cable comprises conductors 1, 2 and 3 which are connected as earth, live and neutral conductors in a conventional manner as indicated by letters E, L and N. Capacitors 4 and 5 are connected between conductors 2 and 3 so as to define a closed signal loop made up of the capacitors 4 and 5 and the lengths of the conductors 2 and 3 between the capacitors 4 and 5.

A first transformer in the form of a toroidal magnetic core 6 is threaded by the conductor 3. The core 6 is located adjacent capacitor 4 and forms a component of a transmitter unit 7. The transmitter unit also comprises a transducer 8 and an oscillator 9. A second toroidal core 10 forms part of the receiver unit 11 which incorporates a signal processor 12 and a switching unit 13. The system is arranged to transmit signals from the transmitting unit 7 to the receiving unit 11.

The transducer may be of any appropriate form, for example a passive infra-red detector or an ultra-sonic movement detector. The transducer receives an input indicated by arrow 14 and in dependence

upon that input provides an output to the oscillator 9. The input for example may be the infra-red radiation given off by a human in the field of view of a passive infra-red detector. The oscillator applies a signal typically having a frequency between 100 khz and 1 MHz to a winding that threads the core 6. That signal is thus applied to the closed signal loop defined by the conductors 2 and 3 and the capacitors 4 and 5. The signal is thus induced in a winding formed on the core 10 and is applied to the signal processor 12. The signal processor may be a standard tone detector tuned to the frequency of the oscillator 9 which itself may be a standard tone generator. The output of the signal processor may cause the switching unit 13 to provide an appropriate output indicated by arrow 14. That output could for example represent the supply of power to a lighting unit (not shown).

The transmitter and receiver units 7 and 11 could be powered from the same power cable as that which is used for the signal transmission. Preferably connections would be made to that power cable outside the signal loop, that is to the lefthand side of capacitor 4 or the righthand side of capacitor 5 in Figure 1. Such an arrangement avoids main loads on the signal loop affecting the transmitted signal strength. On the other hand the transmitter unit and/or the receiving unit may be battery operated. The capacitors 4 and 5 should have capacitances appropriate to the transmission of the signal frequency generated by the oscillator 9. Typically the capacitors will have a value of 0.01 microfarads.

In the arrangement of Figure 1, the closed signal loop is formed between live and neutral conductors. The signal loop could however be formed between for example the earth and neutral conductors and if this is the case then in application where the earth and neutral cables are interconnected at a power distribution board it is only necessary to introduce one capacitor to close the signal loop. Such an arrangement is shown in Figure 2.

Referring to Figure 2, equivalent components to those shown in Figure 1 carry the same reference numerals. It will be seen that the earth and neutral wires 1 and 3 are interconnected at a terminal 16. The toroidal core 6 of the transmitter unit (the other components of which are not shown) is threaded by the neutral wire between the

terminal 16 and a terminal 17. Terminals 18 and 19 are connected to the live and earth conductors. Thus two parallel power distribution circuits extend from the terminal 17, 18 and 19.

Receiving unit toroidal cores 10 are provided in each of the parallel circuits as are shunt capacitors 5 which are connected between the neutral wires 3 and the earth wires 1. Thus two receiving units can be provided, one in each of the parallel power circuits, each receiving unit being responsive to signals transmitted from the transmitter core 6. The two receiving units could be identical or could be tuned to different frequencies. If the receiving units are tuned to different frequencies it would be necessary for the transmitting unit to selectively apply either one of those of different frequencies to the core 6.

It will be appreciated that more than one transmitter and receiver could be connected to a single signal loop. It will also be appreciated that transformers of a different form from the simple toroidal core illustrated could be used. For example, the toroidal core could be retained but in splitable form so that power conductors could be threaded therethrough without disconnecting the power conductors from the power circuit.

CLAIMS:

1. A method for signalling through a power cable, wherein at least one capacitor is connected between first and second conductors of the power cable to define a closed loop incorporating portions of the first and second conductors, signals are injected into the closed loop via a first transformer a winding of which is connected in series with the closed loop, and signals are received from the power cable via a second transformer a winding of which is connected in series with the closed loop.

2. A system for signalling through a power cable, comprising a signal transmitter, a signal receiver, at least one capacitor connected between first and second conductors of the cable to define a closed signal loop, a first transformer having a first winding in series with the signal loop and a second winding connected to the transmitter, and a second transformer having a first winding in series with the signal loop and a second winding connected to the receiver, whereby signals applied to the first transformer by the transmitter may be detected by the receiver connected to the second transformer after transmission through the closed signal loop defined by the first and second conductors and said at least one capacitor.

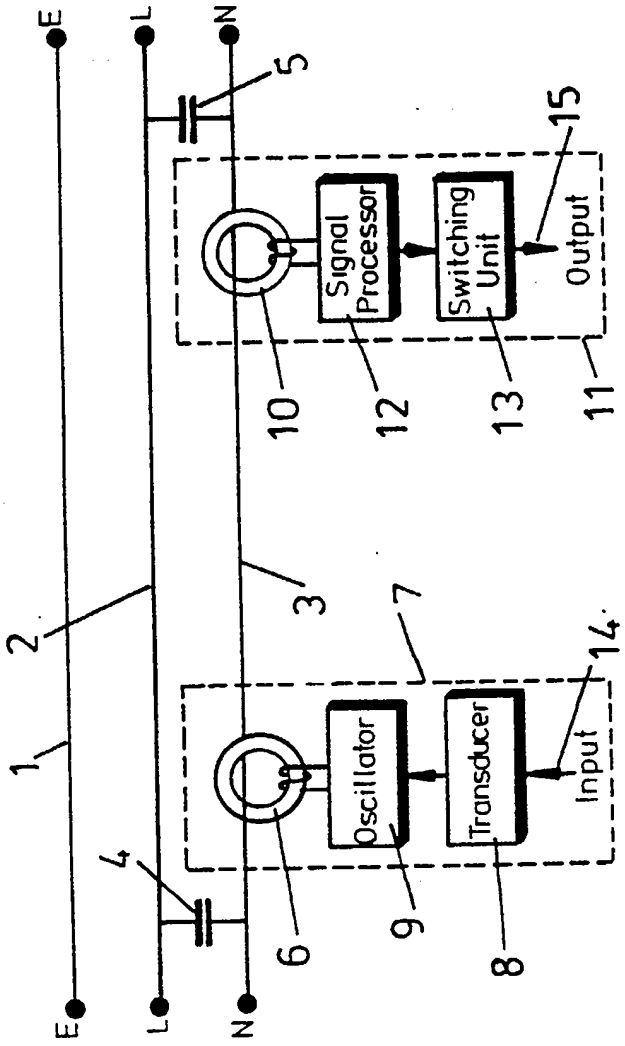
3. A system according to claim 2, wherein two capacitors are connected between the first and second conductors at locations spaced apart along the length of the cable, each transformer being connected to the cable between the capacitors adjacent a respective one of the capacitors.

4. A system according to claim 2, wherein a single capacitor is connected between the first and second conductors, the first and second conductors being directly interconnected at a power distribution point.

5. A system according to claims 2, 3 or 4, wherein each transformer comprises a toroidal core threaded by one of the power cable conductors and by a wire representing the second winding which is

looped around the core.

6. A system according to claim 5, wherein each core may be split into two halves that are positioned around a conductor of a power cable without in any way disconnecting that power cable.


E
L
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5
15
Signal Processor
Switching Unit
Output
10
12
13
11
2
3
7
14
1
Oscillator
Transducer
Input
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6
9
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E
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FIG. 1

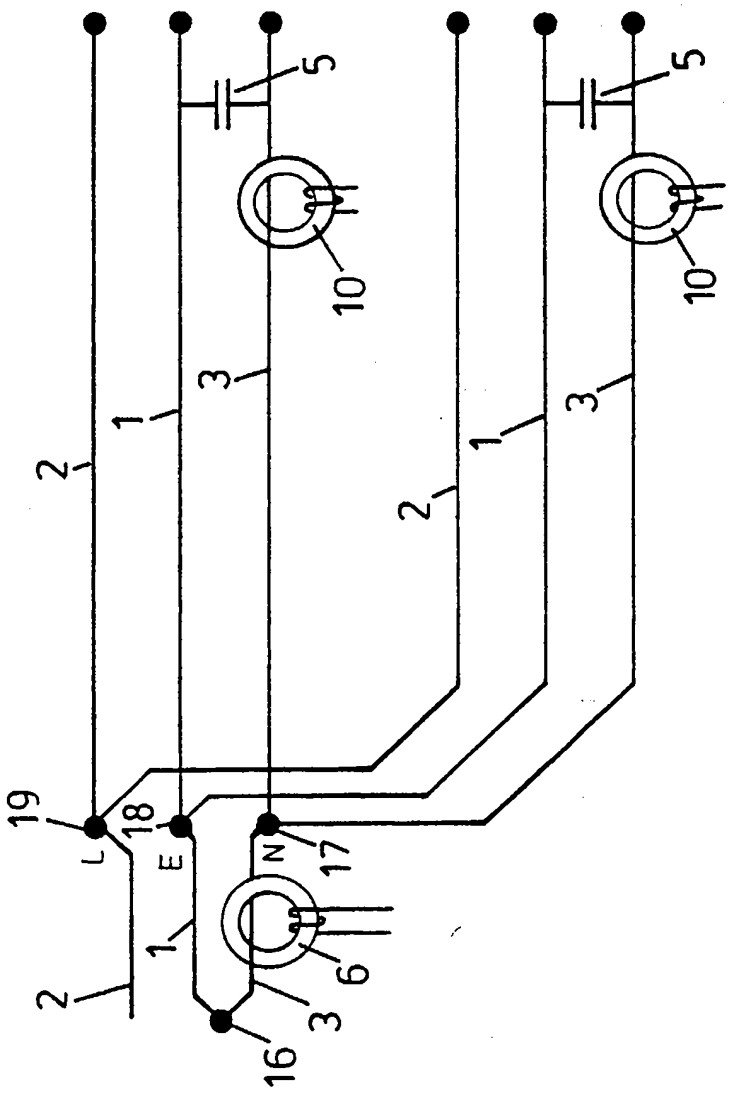

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 92/00456

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 G08B25/06; G08C17/04; H04B3/54

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	G08B ; G08C ; H04B ; H02J B61L

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
Y	US,A,4 745 391 (GENERAL ELECTRIC CO.) 17 May 1988 see abstract ---	1-6
Y	EP,A,0 057 632 (JEUMONT-SCHNEIDER) 11 August 1982 see page 3, line 13 - page 4, line 10; figures 1-2 ---	1-6

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
18 JUNE 1992	30. 06. 92
International Searching Authority	**Signature of Authorized Officer**
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9200456 SA 57525

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 18/06/92
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-4745391	17-05-88	None		
EP-A-0057632	11-08-82	FR-A-	2498546	30-07-82
		AU-B-	549842	13-02-86
		AU-A-	7974982	05-08-82
		CA-A-	1179755	18-12-84
		US-A-	4487385	11-12-84